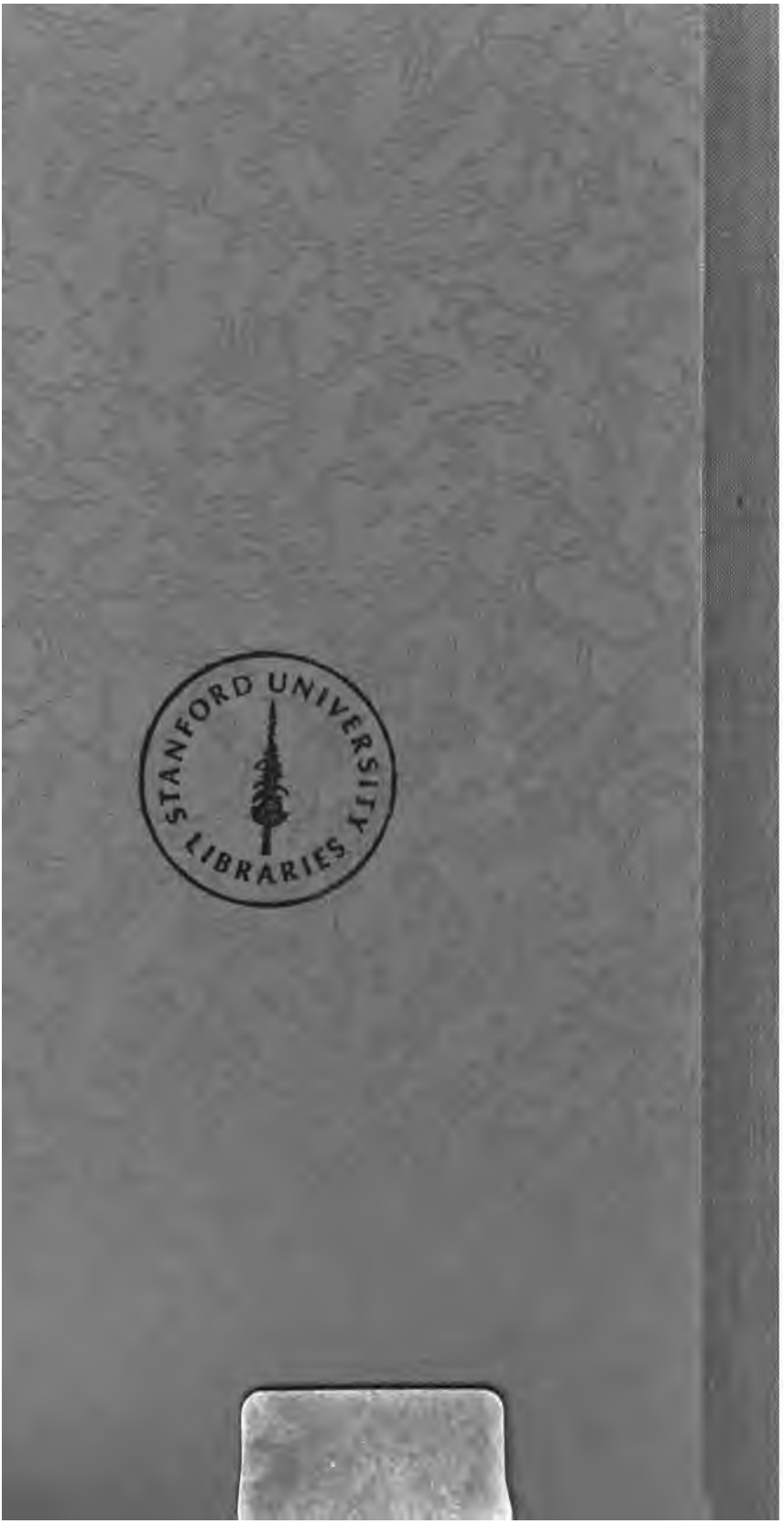

REPORT

OF

Professor George Davidson

UPON A

System of Sewerage

FOR THE

CITY OF SAN FRANCISCO.

SAN FRANCISCO:
FRANK EASTMAN & CO., PRINTERS, 509 CLAY STREET.
1886.

REPORT

OF

PROFESSOR GEORGE DAVIDSON

UPON A

SYSTEM OF SEWERAGE

FOR THE

CITY OF SAN FRANCISCO.

SAN FRANCISCO:
FRANK EASTMAN & CO., PRINTERS, 509 CLAY STREET.
1886.

REPORT.

San Francisco, Cal., April 15, 1886.

To the Board of Supervisors
of the City of San Francisco:

In compliance with your Resolution, No. 18,470, (New Series,) I make the following report upon the essential points involved in an effective system of sewerage for the City of San Francisco.

I have not entered upon any details; I could not have given time for their treatment had I wished, because a steady pressure of official duties has prevented an earlier transmission of this condensation. Moreover, I have recommended a safer means of arriving at them.

THE ADVANTAGES AND THE DISADVANTAGES OF THE LOCATION OF SAN FRANCISCO FOR SANITARY IMPROVEMENTS.

I recall no city that is so peculiarly situated as San Francisco for its commercial and manufacturing advantages, and for its high possibilities in the application of the principles of sanitation—the increase of population depending upon the former demands the development of the latter. Yet I fail to recall but one other where the sewerage is in such a deplorably low condition; that exception is the City of Mexico, which is simply in a horrible plight; but it is so unfavorably situated, and the finances of the country are so low, that there is the semblance of an excuse for its unfruitful efforts. In comparison, we have no excuse whatever.

San Francisco is uniquely placed upon a peninsula less than seven miles broad, with the ocean water upon three sides, and with strong summer winds from the sea to replace the foul airs of a great city.

It has a remarkably equable climate dependent upon the nearly uniform temperature of the surrounding ocean water.

It has reasonably large tides of a peculiarly favorable type for the system which I propose; and very strong currents through the Golden Gate.

It has within its boundaries mountain masses, modestly denominated hills, rising to nearly one thousand feet above the ocean; and the valleys give it marked lines of drainage.

It has its drawbacks, arising from its situation—such as the steep grassy hillsides, draining very rapidly the storm waters of the winter upon the flat lands; the large areas of Mission creek and bay; and of Islais creek, lying at the level of San Francisco bay; the rocky headlands of Telegraph Hill, Black Point, Fort Point, Point Lobos, &c.; the long distance from which the water supply is derived.

There are drawbacks of climate, such as the long, dry summers without rainfall, the occasional storms of winter bringing a large precipitation of rain water.

There are artificial drawbacks: The plan of the city has been laid down without regard to the orographical features of the peninsula—the projected extension of the city over large areas now covered by deep water—the system of sewerage has not been part of a consistent and coherent scheme—along a large frontage the sewers are tide-locked—there has been a policy of economy that is actually preventive of a final economical system—there has been no organized body to devise and carry out any system.

The natural drawbacks may, in a large measure, be overcome; and some of the artificial drawbacks may be corrected.

THE SEWAGE OF LAST SEASON.

The character of the sewage during the last season has been shockingly bad. The foul smells from every inlet to the sewers have been worse than I have heretofore encoun-

tered. It has been shown, upon trustworthy evidence, that the low-lying sewers had become so filled with human excreta and filthy products, that they afforded no proper outlets to the waters of the bay.

Even if these pest-breeding products were promptly carried out by the sewers, they would be deposited with the waters among the wharves. This in itself leads to deposits around our city front, which, if not removed by dredging, will make the waters lethean as those of Venice or Amsterdam.

The sanitation of this city, as of all great cities, is a necessity that cannot be pressed aside; and we cannot ignore the experience of older municipalities that have struggled with defective plans, until compelled by the exigencies of the case to adopt larger views and effective methods.

THE PRINCIPAL CONDITIONS CONTROLLING THE SEWERAGE OF SAN FRANCISCO.

The problem of the sewerage of San Francisco is principally controlled by the low-level areas being so nearly the level of the waters of the Bay of San Francisco.

As at present projected the system is tide-locked, and many important sewers necessarily have their gradients too small for the prompt movement of the sewage. Thus handicapped they have the additional duties of carrying away many waste products of manufacture that should never enter a sewer. They are also required to carry away the ordinary rainfall, and the storm waters with the material borne in thereby. Moreover, from the paucity of buildings in certain sections, it is doubtful if the water used in the dry season is sufficient for the duty required in the transportation of the heavier material in the sewers.

The discharge from such sewers is slow and doubtful; putrefaction necessarily takes place in them; the waters around the city front are polluted; the docks are filled with abominations; and during storms there is continued destruction of sewers and private property.

These are some of the logical consequences of a tide-locked system of sewers. Not one of them should be allowed to remain; they can all be remedied.

IT IS FEASIBLE TO CONSTRUCT A THOROUGH SYSTEM OF SEWERAGE.

It is perfectly f asible to devise a system of sewerage *which shall discharge the sewage promptly, keep it from the waters of the bay, control the discharge of the ordinary rainfall, and even the storm waters.*

This prompt discharge will prevent much of the putrefaction in the sewers, and relieve the present and prospective docks from their filling of filth.

A system to meet the many conditions demanded, and to utilize the present sewers as far as practicable, *must combine the movement and discharge of part of the sewage by gravitation, and another part of the sewage by gravitation and by lifting.*

The movement of the sewage by gravitation is the least expensive after the first cost has been incurred; and, therefore, as much of the sewage as possible should be disposed of by this means, unless the interest on the first cost is greater than the actual cost of discharge by some other effective method.

The movement which requires final lifting and periodical discharge should be made to embrace all the conditions of effectiveness at the least possible expense.

The discharge of the rainfall by the sewers is an open question in most cities where the rainfall is somewhat evenly distributed throughout the year; but in a city like San Francisco, where several consecutive months pass without rain, it is certain that the first rains of the autumn have been looked upon as necessary to cleanse the present sewers. If a daily ample supply of water were discharged into a perfect system of sewers, this rain water might not be necessary. One thing does appear certain—it is not necessary for the storm waters to be carried by the sewers.

If the sewage were wholly and effectively discharged by gravitation, all rain waters might be conducted away by the

same system of sewers; but every gallon of rain water that has to be lifted with the sewage costs money; therefore, only the least amount of rain water that can be properly utilized should be admitted to the sewers—the rest should be discharged by drainage sewers, or in part over the surface of the streets to aid in cleansing them.

Wherever gravitation is the cheaper method it should be adopted for the sewage of the higher grounds, independently of the method by gravitation and lifting; and in that case, the rain water entering the high level sewers simply demands efficient size, form, shape, slope, and good workmanship. Even much of the storm waters may be discharged by this high level system. These storm waters have more destructive force in San Francisco than in any other large city, because of the excessive slopes of the high hills in the heart of the city, as built and as projected. On account of their torrential velocity down the steep gradients, and the sudden change of gradient to nearly dead level in some localities, their destructive action is increased at certain points of their descent. Above these points they should be diverted wholly from the low level part of the system.

THE SYSTEM OF SEWAGE SHOULD NOT EMBRACE THE UTILIZATION OF THE SEWAGE.

In every city there have been many projects for utilizing the sewage directly, or the products of the sewage, in the fertilization of the low lying lands. It is safe to say, that of the two or three hundred of sewerage projects which have been proposed to the Metropolitan Board of Works (of London), nine-tenths of them contemplated the application of the sewage for manure, in one way or another.

It may, at some future day, be desirable to carry the sewage of San Francisco along the western shore of the bay to the swamp, and overflowed, and low lying lands south of San Bruno mountain; but we may leave that matter for the future to settle.

We have no strained utilitarian conditions similar to those of the great cities of Europe; and to-day we must simply but effectually get rid of the obnoxious matter in the shortest and cheapest manner.

THE MAIN POINTS PROPOSED FOR A COMPETENT SYSTEM OF SEWERAGE—THE GREAT LOW LEVEL SEWER.

Based in the main upon the foregoing considerations, I make the following propositions:

That around the water front of the City of San Francisco, in and under the great thoroughfare (which was recommended by the United States Advisory Board of Engineers,* and adopted and being built by the State Harbor Commissioners), there shall be constructed a continuous low-level sewer of ample dimensions to carry the present and the prospective sewage of all the low lying districts of San Francisco.

That this sewer shall be so low along the eastern and northern fronts of the city that all sewers running into it shall effectually drain every building and insure dry basements.

That this sewer shall be projected from the vicinity of Hunter's Point; follow the line of the great thoroughfare round to the limit of the city at the eastern boundary line of the Presidio Reservation.

That the gradient of this sewer shall be sufficient to guarantee the prompt passage of all matter properly admitted to the sewers.

That at the western extremity of this sewer the sewage shall be pumped from the sewer into covered reservoirs whose bottoms shall be at the level of the higher high tides of the bay. That these reservoirs can be readily located in the low grounds of the bay shore near the Presidio Reservation.

That after the stand of each higher high tide of the twenty-four hours the reservoirs shall be opened and the sewage

*Report of the United States Advisory Board of Engineers, John Rodgers, Rear Admiral, U. S. Navy, George Davidson, U. S. Coast and Geoditic Survey, Geo. H. Mendell, Major of Engineers, U. S. Army. Dated March 18, 1877. Not printed.

discharged into the strong current of the large ebb tide. (Our tides are peculiarly favorable for this mode of discharging, because they afford one unusually long and large ebb in the twenty-four hours, with a very strong current that averages more than six miles per hour in the Golden Gate.)

THE GREAT HIGH LEVEL SEWERS.

That a second part of the system of sewerage and drainage, independent of the proposed low level part, shall be the high level sewerage and drainage.

That the main sewer or sewers thereof shall be constructed so as to carry their contents by gravitation to the same reservoirs as the low level system, or to adjacent reservoirs of the same character; and that the discharge thereof shall be done in the same manner as that of the low level system.

That this part of the system shall comprise main lines at different heights, and shall utilize all the sewers now existing above them.

That where it is necessary to carry the sewage of this high level system a long, roundabout distance to reach the reservoirs, a tunnel or tunnels shall be introduced to insure the prompt discharge of the sewage; and these tunnels need not follow any given line of streets, but may run by the shortest practicable routes to the receiving and discharging reservoirs.

THE TIME REQUIRED FOR THE EXECUTION OF THIS PROJECT.

It is granted that it will be some years before the great thoroughfare can be built; but when a system of low level sewerage is decided upon, it should be in co-ordination with the plans and methods of the State Harbor Commission. And the two works can be constructed together with a great saving of expense to each. (In their report of 1877, the United States Engineers gave, as one of their reasons for making the great thoroughfare two hundred feet in width,

the use of this avenue for a system of sewerage. I then brought this low-level system to the notice of the Board, but it was considered to be outside the object for which their appointment was made.)

It is very important that this low-level sewer should drain the low-lying area of the Mission Valley, and those valleys connected therewith, as early as practicable; and the two works—the great thoroughfare and this part of the system—could be commenced at the Point of Rocks, carried across Mission Bay, and thence around the city front to the Presidio boundary. That part of the main low-level sewer lying to the southward of the Point of Rocks could be constructed subsequently.

THE GREAT LOW-LEVEL SEWER IS FOUNDED ON LARGE EXPERIENCE.

That the system primarily involving a great low-level sewer around the city front is the true one, there has never been the shadow of a doubt in my mind. It is beyond the criterion of experiment. It is in successful operation, and we must be warned and guided by the experience of London in the long agitation that eventuated in the adoption of the low level system in 1858.

The almost exhaustive examination of the best engineers, the largest contractors, experienced sanitarians, and agriculturists, affords a large fund of useful information on the question of sewerage. At that time there were, among two hundred schemes, two projects which contemplated the movement of the sewage, one direct to the German Ocean, the other to the Thames Haven at the head of the Thames Estuary. These schemes had great and far seeing merit, but they appeared too vast to be undertaken without experience.

The present London system was one of many, of nearly of equal character, wherein it was required to utilize the pre-existing system, as far as practicable, and to carry the sewage beyond its tidal return to the limits of the metropolis. But it has been proven to be unequal to the demands upon it in

certain sections, and is not sufficient for the increasing population. Already vast projects are being discussed for its extension. Up to 1864 the sum of $20,000,000* had been expended on the present low-level system. The proposed extensions carry the sewage down the banks of the Thames to Thames Haven, nineteen miles below the Erith marshes, near the present outfalls. At this part of the river it is one and a half miles wide, and but a short distance above the head of the estuary.

The first cost of this proposed undertaking is...$16,830,000
And the annual pumping, capitalized at 3½ %... 5,350,000

Or a total cost of.....$22,180,000

The second project is for the precipitating and deodorizing of the sewage of the metropolis at the present outfalls (discharging reservoirs) and barging away the sludge.

First cost.....$ 5,700,000
The annual cost of precipitation and barging, capitalized at 3½ per cent.....13,440,000
If deodorized, add annual cost capitalized at 3½ per cent..... 3,000,000

Or a total cost of.....$22,140,000

It should be distinctly understood that these projects are not matters of sentiment, nor freaks of engineering, nor schemes of plunder; they are the logical deductions from teachings that had already cost as much money. We may not ignore this experience save at increased expenditure. Our present system is totally inadequate for the present population; it is absolutely necessary that we build for the exigencies foreseen in a population two or three times as large, and with the great industries requiring still larger supplies of water.

OTHER LARGE CITIES PROFIT BY THE LONDON EXPERIENCE.

If my recollection is good, the city to first adopt the London low-level system was Berlin, in 1875, when a commis-

*Bazalgette's answer, No. 5,119. Report on Sewage of the Metropolis, 1864.

sion visited London to study the details and to gather statistics and tracings of the plans. In 1878 I saw the work progressing. The sewage is pumped up from the low levels and may be discharged into the Spree, or diverted upon low-lying lands for manure.

Two practical examples, in our own country, are the cities of Boston and Providence.

The experience of these large cities clearly indicates that, in the adoption of the low-level system, sound engineering, good sanitation, and business financial conditions were carefully considered, and practically carried out.

We need not be startled and misled by the cost of the work in London. The situation of that metropolis compels the adoption of long lines of sewers to reach non-returning tidal waters; we have the ocean almost at our doors. The first projects reckoned upon a population of between three and four millions: the second projects estimate for a population of five million two hundred thousand people. Moreover, the first undertaking was a very difficult piece of engineering, being carried under the heaviest business parts of the city, through the foundations of buildings and through quicksands; and the cost was necessarily very great.

The works of Providence and Boston show that the undertaking is within our financial reach.

If San Francisco undertakes this system, while the great thoroughfare is being built, it will cost much less than when the improvements have been completed. It will, of course, require the lowering of some of the sewers which are ineffectually draining the low-lying areas of the city; but these may be utilized in draining the storm waters, and new sewers constructed. All future sewers will necessarily be built in conformity with the new system.

THE VENTILATION OF THE SEWERS.

The ventilation of the sewers has been considered second only in the many questions involved in a system of sanitation. The present fashion is to ventilate the sewers by di-

rect communication with the atmosphere; and the latest mode is to carry the foul gases to the height of the roofs of the houses which have their sewer pipes ventilated.

Some serious errors have been published about the great pressure of the sewer gas in our sewers. As a matter of fact, it is usually very small; it is never great, and can be easily measured.

In this city, after a few warm days, the sewer gas escapes freely from the street openings, especially when an easterly wind is blowing into those sewer outlets that may be exposed at low water. If the house-trap is unsealed, the sewer gas finds its way into the rooms.

The quantity of sewer gas which ordinarily escapes from a sewer would not be deleterious if it did not carry with it the foul products of putrefaction, and the germs of disease. Let any one stand over a sewer inlet that is untrapped, and make up his judgment by the sense of smell, if not satisfied by the direct investigation of others.

In an interesting and instructive report on the ventilation of sewers, published by the Metropolitan Board of Works, the essential points of each proposition submitted for such ventilation, or for the deodorizing of the sewage, from 1856 to 1874, are specifically mentioned. It is clear therefrom, that notwithstanding the importance of this subject, and the great value of any successful method, no one means has been found effective.

And in the voluminous reports of the Metropolitan Board of Works for 1853, 1857, and 1864, involving probably more than ten thousand questions and answers, the opinions of some of the most eminent engineers are given on the subject, but no satisfactory scheme has been educed.

In 1878 I learned, by personal inquiry from the engineer of the Board of Works, that up to that date no efficient solution had been reached.

In that year I directed some experiments that were made upon the matter carried by the gases in the sewers of a certain part of this city. I give the general results in the two letters appended to this report.

I am adverse to allowing the sewer gas to escape into the air we are breathing. I am in favor of effectively trapping every inlet to the sewers whether from street or house; but, knowing that there occurs slight pressure of this sewer gas when it is expanded by heat or by the wind blowing into the outlets of the sewers, I would relieve this pressure and at the same time destroy the putrefying particles and the so-called germs of disease. So far as I can judge, these results are most effectively attained at one and the same time by passing the escaping sewer gases through flame.

In further explanation of a practical method of doing this I append, as part of this report, copies of two letters which I addressed to Hon. John F. Swift, in answer to inquiries from him. I have to this time gathered no information to warrant me in changing the views therein expressed.

HOW SHALL THE PROPOSED SYSTEM OF SEWERAGE BE PAID FOR?

The question of the manner of paying for this important undertaking naturally comes to the front. The cost is a matter embraced in any project of engineering. In this case, if the limit of one dollar per hundred taxation be the inflexible rule of the city's financial policy, the sewerage must remain not only ineffective but destructive to property and to health. As the population increases all the disadvantages, and the cost, must be multiplied in even greater ratio.

Other large municipalities have undertaken such works upon the same principle that the artisan, without present means, builds a home for his family and pays interest on the money advanced by the lender until the principal is paid off. In other words, the municipality can afford to mortgage its credit for such a substantial and necessary improvement by giving its bonds, as consistently and safely as the mechanic can mortgage his lot and house whereby he may construct the latter. Such bonds would enable the city to obtain money as needed at the lowest possible rates.

RECOMMENDATION FOR A BOARD OF PUBLIC WORKS.

I cannot close this short report without referring to a matter so intimately connected with the sewerage problem that I do not see how they can be separated.

Judging by the experience of other great municipalities, and by the successful practice of large organizations in manufactures, commerce, finance, legislation, and engineering, I have always believed that the engineering of this city should be done under the direction of a *Board of Public Works*, consisting of not less than five properly qualified persons, with ample powers and with sufficient checks as safeguards.

The questions involved in the engineering of this city are of so much moment to the welfare and well-being of the community that they should not be confided to a single person; and as the city increases in population and manufactures, many unforeseen conditions will necessarily arise that demand the varied thought of a composite body.

The proposed Board should consist of three engineers and two business men, with power (among others) to call in experts for special investigations. Its composition at the outset would have to meet the confidence of the community, and would largely influence the value of the bonds. Its continuance and mode of change should be beyond the influence of partisanship and the machinations of evil designing men.

Very respectfully,

GEORGE DAVIDSON.

APPENDIX No. 1.

SAN FRANCISCO, CAL., February 6, 1878.

HON. J. F. SWIFT, Sacramento, Cal.

Dear Sir: To your two propositions upon:

1. The possibility and practicability of destroying the deleterious effects of sewer gas? And

2. What efforts have been made in larger cities in that direction?

I beg leave to answer:

First.—This is a subject that has deeply interested the authorities and engineers of all large cities; and even in late years rewards have been offered for the most efficacious method of getting rid of sewer gas, or of destroying its deleterious effects.

Second.—The sewer gas *per se*, or as a medium for carrying deleterious agents, would be innocuous if confined wholly to the sewers.

Third.—But this cannot be effected by any of the methods tried; it escapes at the outlets of the sewers, at street inlets, through house drains, by leakage, saturates the soil, etc.

Fourth.—As the sewer gas must therefore escape into the air we breathe, many attempts have been made to carry it into the higher parts of the atmosphere by ventilating shafts of various contrivances.

Fifth.—These must be ineffectual unless the ventilating shafts are numerous; and when effectual the whole atmosphere must be more certainly filled with the sewer gas and its contaminations.

Sixth.—If the sewer gas escape at the outlets of the sewers, or at the street inlets, the immediate air is poisoned.

Seventh.—If it escape into houses, the air of the rooms is vitiated and filled with the germs of zymotic diseases.

Eighth.—In fact, whenever sewers are ventilated the sewer gas must necessarily escape into the atmosphere with its disease germs.

Ninth.—Many expedients have been tried to "ventilate" sewers; to "deoderize" them; to "arrest the putrefaction of sewerage by chemical means," and by sulphur flames; to "destroy the offensive sewer gases by means of charcoal ventilators;" to "purify sewers by drawing smoke into them;" to "prevent the escape of sewer gas," etc., etc.

Tenth.—These and many other methods are chronologically specified and considered in a special *Report on the Ventilation of Sewers*, lately published by the Metropolitan Board of Works of London.

Eleventh.—Believing that the most efficacious method is by heating the sewer gas to such a temperature as to destroy the vitality of the germs of disease carried by it, I last year addressed a letter to the Chief Engineer of the Metropolitan Board of Works, and asked him if there was any place in Great Britain where sewer gas was burned to destroy its deleterious effects.

Twelfth.—His letter of July informs me that he is "not aware that there is any place in Great Britain where sewer gas is burned to destroy its deleterious effects," etc., and refers me to the printed report above mentioned as containing the latest information on the subject. (1876.)

Thirteenth.—I believe it is feasible to so heat the sewer gas as to destroy its deleterious qualities, or destroy the disease germs it carries, and at the same time to ventilate the sewers thereby.

Fourteenth.—This I have witnessed in the burning or heating of sewer gas directly from a sewer, in the flame of a gas-burner.

Fifteenth.—I believe it may be applied to all the street lamps of a city; and that there is apparently no great difficulty in the proper application of the means.

Sixteenth.—Such a method seems to combine all that is desired in the disposition of sewer gas—destroying the *Bacteria*, and other germs of disease, and ventilating the sewers so that they may be safely entered by workmen, when the necessity arrives for cleansing or repairs.

Very respectfully yours,

GEORGE DAVIDSON.

APPENDIX No. 2.

SAN FRANCISCO, CAL., Feb. 15, 1878.

HON. J. F. SWIFT, Assembly of California, Sacramento, Cal.

Dear Sir: In reply to your letter of the thirteenth, I would state (as in part also explanatory of my previous letter) that I have witnessed and am cognizant of certain experiments made in this city, with a method for destroying the deleterious effects of sewer gas.

The experiments were mostly made at my suggestion, and so far they have shown the following results:

First.—That the sewer gas carries with it the germs of disease.

Second.—These disease germs are destroyed by burning.

Third.—The means which I have examined are applicable to street gas lamps.

Fourth.—The photometric value of the light is so little affected that the change cannot be detected, except possibly by rigid photometric experiments.

The method proposed is that patented by S. J. Corbett, and consists in burning the sewer gas brought in contact with the gas flame. I witnessed the operations several times some months since. The germs are subjected to the heat of the flame and their vitality destroyed, whilst the offensive odor accompanying sewer gas is also destroyed.

As part of the experiments I may mention that glycerined glass plates were exposed in the sewer near the Palace Hotel, where the exhaust steam enters the sewer, and yet the following results were obtained by two microscopists:

"Examined soon after the washing was made, a sedimentary deposit of vegetable fibres and other matters was noticeable to the unaided vision. Drops placed under a microscope, with an amplification of from 300 to 1,300 di-

ameters, were found to contain vegetable cell structure, spiral ducts and fungus spores.

"*Bacteria*, one of the earliest vegetable forms appearing in decaying and putrefying animal and vegetable solutions, and by many regarded as the cause of putrefaction and of zymotic diseases, were found in large numbers.

"*Spirilla* were also discovered, but not plentifully. A growing fungus somewhat arborescent in form and answering to Torula, found in decomposing urine, was noticed in many instances, the filamentous mycelium spreading in all directions.

"Monad-like forms were plentiful, which were probably the zoospores of some of the lower algæ, and a few spiral filaments answering to the description of *gyrocerus* of the genus *Torula* were found. These forms are all found in decomposing and fermenting solutions and matter, and their presence would seem to prove that the gases arising from our sewers are laden with the germs of disease and death, and to such an extent as to contaminate and corrupt the purest air and water.

"Without doubt diphtheria and other diseases of a material character would be lessened by the destruction of such germs as are known to be their cause or stimulant; and it would seem proven from this and other tests made, that to this end our sewer gas should be made a point of vigorous attack."

It may be remarked that one method of disinfecting sewers has been to send steam through them; yet here, where the steam had a fair field, the results exhibit its inefficiency.

Other similarly prepared plates exposed to the sewer gas from the drain-pipe of the Grand Hotel gave nearly similar results.

Dr. Wythe, the microscopist, furnished a drawing which exhibited a large number of foreign objects, among which he enumerated fibres of cotton, vegetable debris, sand, charcoal, etc., growing fungi, bacteria, eggs of insects (?), &c.

It was not practical to make, without much trouble and inconvenience, exhaustive photometric experiments; but the indications obtained satisfied me that the change of illumination is very small, and one observer reports it wholly unappreciable.

Although I am convinced that the results are satisfactory, yet to satisfy others it would appear proper to have a full series of observations and experiments made upon some of the city lamps and sewers by the city authorities, under the direction of competent persons, for which purpose the city might be authorized to expend a sum not to exceed three thousand dollars.

Yours respectfully,

GEORGE DAVIDSON.